Studentoppgave
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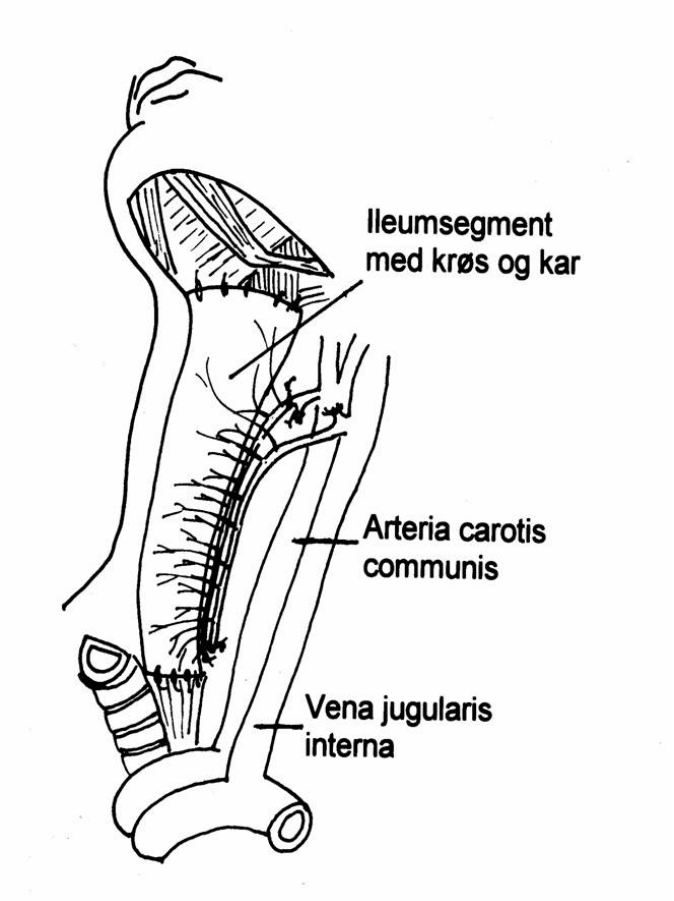
Radiological analysis of swallowing and functional outcomes after laryngopharyngectomy with reconstruction using a jejunal autograft.



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Abstract

Background: Swallowing is normally initiated voluntarily, and afterwards presumed controlled by brainstem reflexes. Resection of the hypopharynx with reconstruction using a jejunal autograft may conceivably affect this control.

Purpose: This study was an attempt to perform a biomechanical analysis of the motility in the small bowel graft and suggest possible implications for surgery. We also tried to describe how passage through the esophagus is affected by this surgery and compare our objective assessment of the patient's swallowing function with the patient's subjective experience.

Material and Methods: Five patients underwent a radiological examination of the neopharyngeal conduit and esophagus and completed a questionnaire.

Results: We observed a peculiar movement of the base of the tongue in all patients with varying degrees of thrust. The passage through the jejunal graft was passive and dependent on the tongue and gravity. Graft contractions were observed late in transit and only emptied a residual volume. Esophageal transport also appeared to be rather passive and largely depended upon the pull of gravity. Two out of five patients were not able to eat without restrictions regarding the consistence of the food. Their impaired swallowing resulted in severely reduced quality of life.

Conclusion: Tongue thrust is essential for swallowing after pharyngolaryngectomy with reconstruction using a jejunal autograft. We report a distinct movement of the tongue in these patients, probably a compensatory mechanism for achieving propulsion of food. It seems important to implant the jejunal graft properly stretched to restore the funnel shaped opening to the esophagus as well as to avoid blind ends and bends in the jejunal conduit

Introduction:

Resection of the hypopharynx with reconstruction using a free vascularised small bowel graft has become widely used in the treatment of advanced cases of hypopharyngeal carcinoma and laryngeal carcinoma infiltrating the hypopharynx (T3) [1,2].

In healthy individuals deglutition is initiated voluntarily, and afterwards presumably controlled by brainstem reflexes [3]. Laryngopharyngectomy may conceivably affect this control. Consequently we assume that the oesophageal phase of deglutition in these individuals will be different from healthy persons. Previous studies have shown that 53 - 76 % of these patients have satisfactory swallowing function and are able to maintain an unrestricted diet [1,4]. At the time of our investigations there had been little concern regarding the oesophageal phase of deglutition in these patients [5].This study was an attempt to perform a biomechanical analysis of the motility in the jejunal autograft and based on this, suggest possible implications for surgery. Further on we wished to describe how the passage through the oropharynx and esophagus is affected by resection of the hypopharynx and compare our objective assessment of the patient's swallowing function with the patient's own experience.

Materials and methods:

The included patients had undergone circumferential hypofaryngectomy with reconstruction using a free vascularised jejunal autograft. 28 patients have been treated with this method in Rikshospitalet University Hospital from 1989 to June 2007. Five of these were randomly selected among the patients regularly seen at the outpatient clinic at Rikshospitalet. This study was based on a questionnaire and a radiological examination. The patients were contacted by letter and gave their informed written consent to the examination. Approvals from the Regional Ethics Committee and the National Data Inspectorate were obtained. All patients

had histologically verified squamous cell carcinoma. Three patients were operated for primary hypopharyngeal carcinoma and two patients were operated for laryngeal carcinoma infiltrating the hypopharynx. All patients underwent neck-dissection with exposure of the common carotid artery, the superior thyroid artery and the internal jugular vein suitable for vascular anastomosis. An appropriate jejunal segment was harvested and anastomosed end-to-end in an isoperistaltic position. Any discrepancies in lumen circumference between the oropharynx and the jejunal graft was balanced by making a split incision in the antimesenterial wall of the proximal jejunum. The anastomoses were sutured using running sutures with absorbable material. Post operative endoscopic examinations and ultrasuound with Doppler measurements were used to monitor graft viability. The 3 patients with hypopharyngeal carcinoma received postoperative irradiation (50 Gy). The two patients operated for laryngeal carcinoma were both recurrences and had previously received radiation therapy (70 Gy). There were one female and four men, and their age ranged from 49 to 71 years at the time of the examination. The time from surgery to our investigation ranged from 1,5 to 19 years with a median time of 41 months.

Their swallowing function was documented using liquid contrast (Visipaque 320mg/ml, GE Healthcare) to perform a dynamic radiological examination. The fluoroscopy was performed in upright position with digital storage of images at a rate of 12,5 frames per second **(**MD 4, Phillips, Eindhoven, The Netherlands). The neopharyngeal conduit was examined in the lateral and oblique position and the esophagus was examined in the frontal position. It was performed and evaluated by a radiologist (S.A.) trained in functional assessment of the gastrointestinal tract. Ahead of the radiological examination, we interviewed each patient and encouraged them to complement the questionnaire. Each patient was also examined clinically to, as far as possible, exclude tumor recurrence.

Swallowing function after surgical treatment for hypopharyngeal cancer reaches a steady state 12 months after end of treatment [1]. As a consequence of this we invited only patients who were operated some time ago. None of our patients had an observation time less than 17 months.

Results

All patients reported significantly impaired swallowing function after surgery. Three patients were able to eat without any restriction regarding the consistence of the food. Two patients were only able to ingest semisolid or liquid nutrition, which resulted in severely reduced quality of life (QOL). Clinical examination did not reveal signs of local or regional tumor recurrence in any of our patients.

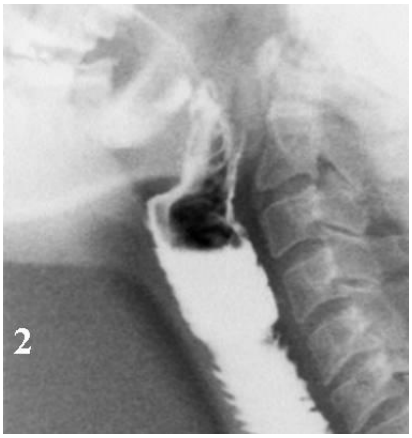
	Patient 1	**Patient 2**	**Patient 3**	**Patient 4**	**Patient 5**
Age and gender	♂, 64 years	♂, 63 years	♂, 49 years	♀, 70 years	♂, 66 years
Diagnosis	Hypopharynx	Larynx	Larynx	Hypopharynx	Hypopharynx
TNM	T2N0	T3N2b	T4N0	T2N2	T3N2c
Swallowing function after surgery	Severely reduced	Severely reduced	Severely reduced	Severely reduced	Severely reduced
Restrictions regarding food consistence	None	None	None	Only semisolid food	Only fluid / semisolid food
Reduced QOL because of poor deglutition	No	No	No	Severely reduced	Severely reduced

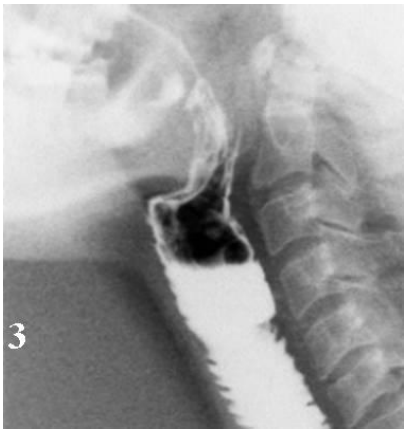
Originally, we had planned to include examination of the esophagus in the supine position. However all patients reported strong discomfort when trying to drink in the supine position, and this part of the examination had to be omitted. The radiological examinations were completed without any complications. Patient 2 experienced some leakage through the Provox, but was able to cough up the contrast and did not report any discomfort afterwards. When we evaluated the radiological examination we found several common denominators. We observed rapid transport through the oropharynx in all cases. A distinct rotating movement of the dorsum of the tongue was observed in all patients with varying degrees of

thrust and efficacy. The pivoting point in this rotation was at the anterior aspect of the upper anastomosis where the jejunal interponate is suspended in the caudal part of the base of the tongue. Through the contact between the base of the tounge and the dorsal wall of the oropharynx we observed that the tongue imparts sort of a piston thrust by closing down on the entire circumference of the anastomosis. (Figure 1-5)

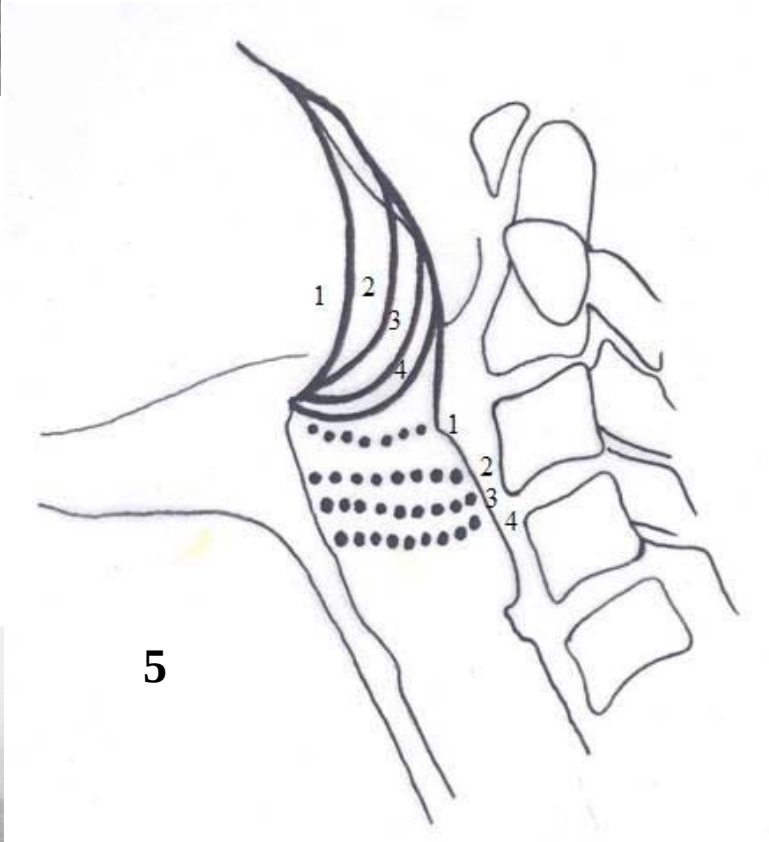
In all but one case there was efficient closure of the tongue against the posterior pharyngeal wall. All patients repeated the rotating movement of the dorsum of the tongue. In patient 4 the tongue did not close against the posterior wall, but still the feeble thrust appeared to be of some importance because the movement was repeated and concomitant flow of the bolus could be seen.

In four out of five patients there was initially a rapid transport of the bolus through the graft. A narrow cranial anastomosis may have contributed to the slow transit through the bowel segment in the last case (patient 4). Initially we did not observe any contractility that contributed to the passage of contrast through the graft. The passage was passive and depended on the tongue and the pull of gravity. There was seemingly a flexible narrowing at the lower anastomosis in all patients. The narrowing permitted passage of most of the bolus, but some contrast was retained and regurgitated. This occurred in all patients, but differed in regards to the volume of the contrast. When contrast regurgitated, we observed graft contractility which pushed the residual volume through the lower anastomosis and emptied the graft. In patient 5 there was inconsistency between the degree of stenosis found by the radiologist and the patient's own history reporting severe dysphagia. In this patient we observed palatoglossal insufficiency and the contrast leaked into the oropharynx and flowed passively down the dorsum of the tongue. In addition the propulsive movement of the tongue appeared to be far weaker than in the other patients.





Backward thrust and rotation of the tongue as it closes down on the cranial anastomosis. Notice a concomitant descent of the bolus. From a consecutive sequence of imagesat a frame rate of 12,5 images/sec, every other image was skipped.
The time interval between images is 0,16 seconds



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Thick line – Dorsum of the tongue
Dotted line – Level of contrast bolus
Numbers in the figure corresponds to image 1-4

An altered pattern of oesophageal transport was observed in all cases. The inverted V-sign which represents the continuous peristaltic contraction against the tail of the moving bolus was virtually absent in all patients. Instead of observing the downward sweeping contraction in the manner of the inverted letter –V, we saw that the contrast floated downwards along the wall of the esophagus, much like a cascade downhill a vertical mountain wall. The transport appeared to be rather passive and largely dependent on the pull of gravity. A true inverted V-sign was temporarily present in brief periods in two of the patients. Transit was slow, dyscoordinated contractions appeared in one case, and regurgitation occurred in two of the patients.

Discussion

Even in healthy individuals, swallowing is initiated by rapid oropharyngeal acceleration before the simultaneous contraction of the pharyngeal constrictor and the backward thrust of the tongue push the bolus further down. In our material we did not observe any initial contraction in the small bowel graft. Our patients will therefore be almost completely dependent on tongue thrust for initial passage through the small bowel autograft. We report an altered pattern of tongue movement. In addition to the backward thrust, there is a rotation of the dorsum of the tongue where the pivoting point is at the upper anastomosis. This mechanism was present in all cases and was also repeated. There is no documentation in the patients' records suggesting damage to any cranial nerves. This makes it unlikely that this alternative movement is a direct result of surgery. It's more likely that this is a compensatory mechanism for achieving propulsion of food through the graft to the esophagus.

The mere fact that these patients were unable to swallow in the supine position suggests that gravity is important for passage through the graft. In four out of five patients the jejunal

autograft appeared to contain air and was dilated prior to passage of the bolus. After the tongue had emptied the contrast into the graft, it repeated the rotating movement and seemed to push against the air behind the contrast. We did not have the opportunity to use manometry. Although we could not estimate the pressures in the graft, the tongue continued the rotating movement even after the contrast had entered the graft, suggesting that the tongue movement is of importance for the passage through the jejunal interponate. We propose that the tongue movement produced increased pressure in the graft which assisted in propulsion of the bolus. The graft appeared to have a constant tone and did not dilate in response to this increase in pressure. By mediating an increase in pressure, the graft will assist in propulsion of food. This pressure increase will obviously work in concert with gravity.

Bergquist et al proposed that the graft ideally provides a generally passive conduit [5]. In general we support this statement, but in our material the graft demonstrated intrinsic motility which proved useful in propulsion of a residual volume.

In healthy individuals the pharyngeal phase of deglutition is initiated by the lifting of the hyoid bone and thyroid cartilage thereby closing the laryngeal opening. This creates a funnel which opens into the esophagus. During the surgery, the hyoid bone and surrounding structures are removed. When implanting the jejunal graft it seems important to make effort to insert the graft properly stretched [6]. Too much tension might compromise microcirculation and will predispose to dehiscence and fistulas, a common complication that should be avoided [2,7]. But by keeping the graft somewhat stretched, the graft tension and basal tone will provide a static lift and recreate the funnel shaped opening to the esophagus. This is probably better achieved by avoiding an pharyngojejunal end to side anastomos that might result in a pseudopouch that delays deglutition [5]. The radiological examinations of the patients who were able to maintain an unrestricted diet demonstrated perfectly a funnel shaped opening which allowed adequate passage through the graft. Patient 4 showed a somewhat flaccid

passage pattern and the graft did not appear to be dilated in the same manner as in the other patients. Graft redundancy is a known cause for dysphagia in these patients and is probably the explanation of her narrow upper anastomosis and reduced swallowing function [2,8]. The patient (patient 5) who reported most dysphagia showed signs of palatoglossal insufficiency, and contrast leaked through the palatine arch before tongue movement was seen. Due to this leakage, the tongue was probably not able to build up enough pressure to adequately "shoot" the bolus through the graft to the esophagus. Patient records show that this patient underwent the most extensive surgery of our patients and pharyngeal tissue extending to the tonsil's inferior border was excised. His poor deglutition can therefore be explained as a post operative result where the anterior palatine arches are not able to close against a smaller tongue thus making it impossible to build up pressure necessary for the propulsion of food. During the examination of our patients we observed an altered pattern of oesophageal transport. We did not observe the inverted V-sign and the passage appeared rather passive and dependent upon the pull of gravity. Normal deglutition is presumed controlled by brain stem reflexes, but oesophageal peristalsis can also be elicited in response to distension independently of intact extrinsic reflexes. [9] When the hypopharynx is removed, a large portion of the pharyngeal constrictor is lost. We observed that passage through the interponated jejunum is predominantly passive and a normal sized bolus is not generated. The altered pattern of oesophageal transport may simply be a sequelae after breaking the presumed reflex arch, but the lack of adequate oesophageal distension is probably also of significance. Bergquist et al found discrepancy between abnormal radiological findings and the mild dysphagia reported by the patients [5]. They also concluded that the global QOL in these patients is comparable to the general Swedish population. In addition to the questionnaire and fluoroscopy we interviewed our patients regarding their experience of their swallowing function. The results of the radiological examinations correlated well with the patients' own

experience of their deglutition. Although three out of five patients tolerated an unrestricted diet, all five experienced their swallowing function as severely reduced since before surgery. The two patients with restrictions regarding the consistence of the diet reported severely reduced QOL as a result of this. This correlates well to the findings of Ward et al. [10]

Conclusion

Tongue thrust, created by the simulataneous backward and rotating movement of the tounge against the dorsal pharyngeal wall, appears to be essential for swallowing in patients who have undergone pharyngolaryngectomy with reconstruction using a jejunal autograft. Most of the food will flow passively through the graft. The graft works predominantly as a passive conduit, but retains intrinsic motility and is able to empty a residual volume. It is therefore important that the graft is implanted in an isoperistaltic position**.** Radiological examination of five patients demonstrated a distinct rotating movement of the tongue in these patients, most likely a compensatory mechanism for achieving propulsion of food. We propose that the tongue movements against the dorsal oropharyngeal wall create an increased pressure in the graft thereby pushing the food further on. By inserting the graft properly stretched, and performing the cranial anastomosis end to end, the natural funnel shape of the opening into the esophagus is restored as well as an increase in pressure by the toungue movement is mediated. This may have implication for the surgeons when implanting the graft as well as radiologists when evaluating radiological examinations after surgery.

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In memory of Thorbjørn Løtveit who was part of the team introducing this surgical procedure in Rikshospitalet.

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